

# INTO

## Universitetsopera i Montreal

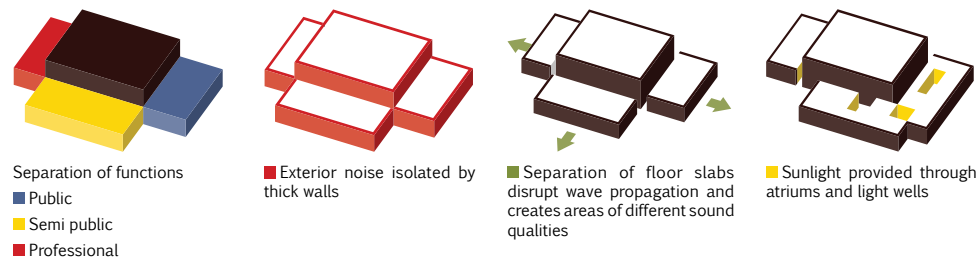
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|             |                                     |  |   |
|-------------|-------------------------------------|--|---|
| Kurs        | Kandidatarbete vid Arkitektur 15 hp | I utkanten av Montreals stadskärna önskar en högskola uppföra en operabyggnad. Operan ska användas för studentuppföranden, likväl som av professionella artister. Förutom opera skall auditoriet även kunna användas för konserter, föreläsningar och dansuppvisningar, och kräver därför variabel akustik.<br>Platsen omgärdas av vältrafikerade vägar och en närliggande tågräls, vilket ställer höga krav på ljudisolering. I projekteringen läggs fokus på akustiska detaljer i alla delar av byggnaden. | Operans tjocka tegelväggar skapar en lugn plats skild från stadens buller medan dess horisontella uttryck tonar ned skalan.<br>Byggnaden är tydligt uppdelad för olika funktioner, användargrupper och ljudbilder. Samtidigt är kommunikationen mellan de olika delarna enkel.<br>Fokus ligger på den akustiska utformningen av auditoriet, och på att skapa förutsättningar för studenter och musiker att mötas på innergårdar och i korridorer i den stilsamma semipublika del som rymmer övnings-salar och omklädningsrum. |
| Termin      | 2:a, årskurs 3                      |  |   |
| Examinator  | Morten Lund                         |  |   |
| Medarbetare | Carl Hoff                           |  |   |

# Intro



A HUMBLE OPERA BUILT ON ACOUSTICAL PRINCIPLES CREATES A UNIQUE MUSICAL VENUE WHERE STUDENTS CAN LEARN FROM THE MASTERS. THE DENSE BRICK WALLS CREATE INTERIOR SPACES OF QUIET TRANQUILITY, VERSATILE AND ADAPTABLE TO VARYING NEEDS.



Traffic 70 dBA  
 Railroad 50 dBA  
 Aircraft 70 dBA

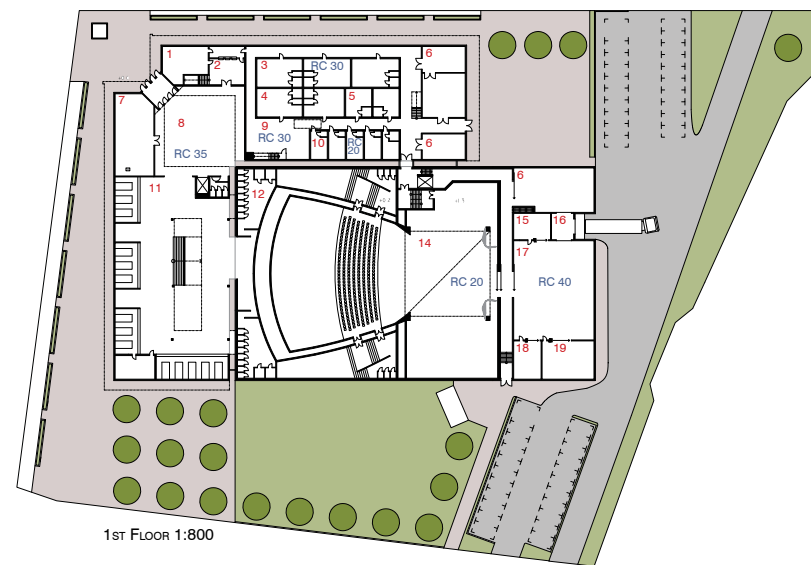
Traffic noise is primarily from the north eastern direction. SPL peaking in mid frequency range.  
 Railroad noise also from the north east, in low to mid frequency ranges.  
 Aircraft noise affects the site omnidirectionally in all frequencies.  
 Best transportational services are located to the north west.

**Audience**  
 - A directed journey through the opera house.  
 - Access to public facilities at operating hours.  
 - Possibility to access green room and main rehearsal room for special events.

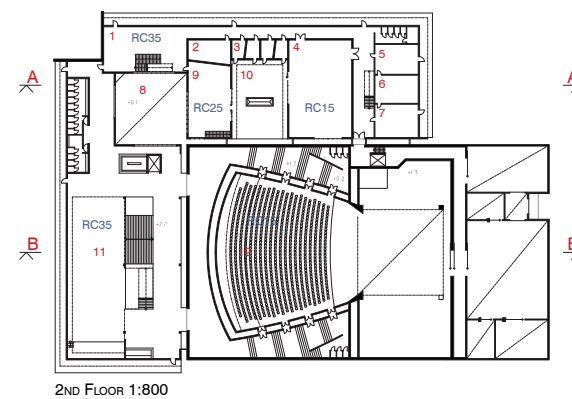
**Students**  
 - Possibility to use the semi public space of the opera freely, not just during operating hours.  
 - Extra rehearsal rooms provided to share between students and professionals, creating opportunities to .

**Performers**  
 - Effective communication between dressing rooms, rehearsal rooms, stage and green room.  
 - Sound insulated dressing rooms close to the stage for pre-performance preparation.

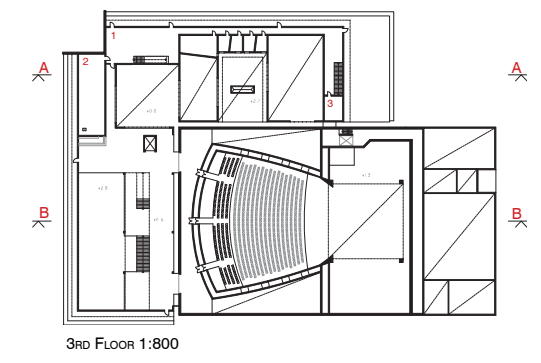
**Workers and staff**  
 - Private entrance, access during all hours.  
 - Obvious logistics, good communications between stage, storage and workshops.  
 - Noisy spaces clustered together and separated from sensitive areas.



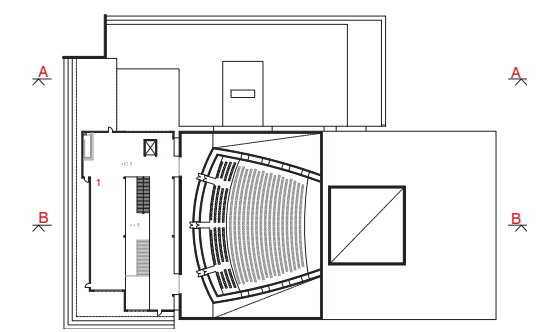
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|----------------------------|------------------------|--------------------|
| 1. HOUSE MANAGERS OFFICE   | 7. CAFÉ / SHOP         | 14. STAGE          |
| 2. BOX OFFICE              | 8. ATRIUM              | 15. METAL WORKSHOP |
| 3. CHORUS DRESSING ROOM    | 9. BREAK ROOM          | 16. LOADING DOCK   |
| 4. ORCHESTRA DRESSING ROOM | 10. SOLO DRESSING ROOM | 17. ASSEMBLY HALL  |
| 5. 4-PERSON DRESSING ROOM  | 11. CLOAKROOM          | 18. PAINT SHOP     |
| 6. STORAGE                 | 12. RESTROOMS          | 19. CARPENTRY      |



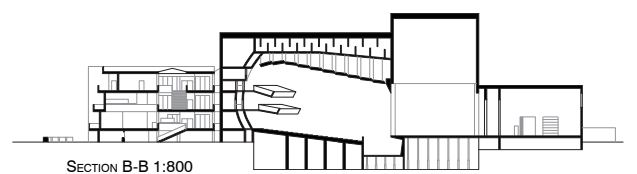
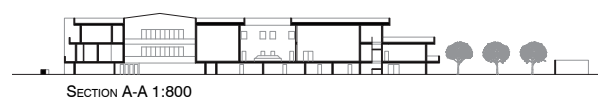
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|----------------------------|-----------------|----------------|
| 1. STUDY AREA              | 5. WIG SHOP     | 9. GREEN ROOM  |
| 2. ENSEMBLE REHEARSAL ROOM | 6. WARDROBE     | 10. COURTYARD  |
| 3. SOLO REHEARSAL ROOM     | 7. COSTUME SHOP | 11. LOBBY      |
| 4. MAIN REHEARSAL ROOM     | 8. ATRIUM       | 12. AUDITORIUM |



- STUDY AREA
- KITCHEN
- RECORDING STUDIO



- RESTAURANT





# REHEARSAL AREA

# LOBBY

## MAIN REHEARSAL ROOM

- Retractable risers for choir practice can also be used as a stage.
- Mirror for dance rehearsals. Can be covered by curtain for added absorption.
- The acoustics of the rehearsal room can be controlled by pulling the curtains and changing the height of the ceiling panels. The panels feature a diffusive side facing down and an absorptive facing up. By setting the panels to different heights, the reverberation time can be lowered during lectures and workshops.

## COURTYARD

- The open air courtyard provides daylight to all rehearsal rooms and the green room from a space absent of traffic noise.
- A light well brings light to the dressing rooms situated beneath. Additional light is brought down in the separating space between the building parts.

## SOLO REHEARSAL ROOMS

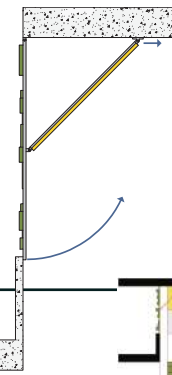
- Diffusers with randomized surface irregularities scatter high and mid frequency sounds.
- Slanted side walls reduce the risk of flutter echoes.
- Double glazed doors allows access to the courtyard while sustaining a high sound insulation.
- Curtains for privacy and variable absorption.
- Absorptive ceiling.

## GREEN ROOM

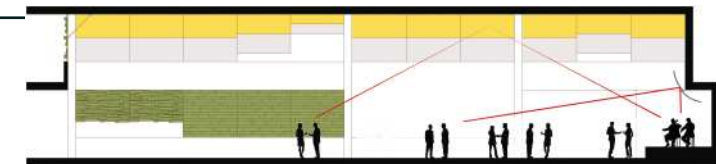
- A stage for small performances, speeches and lectures in the corner is supported by reflective walls for good sound propagation throughout the room.
- A bar makes the room suitable for receptions and special events.
- Easy access to stage and dressing rooms through a hidden flight of stairs.

## HALLWAY

- The hallway acts as a sound buffer between the outside and the rehearsal rooms.
- Dense double brick walls ensures high sound insulation. Glazed perforations let sound inside, creating an engaging interior.
- Ventilation ducts with silencers mounted in the hallway ceiling prevent sound transmission between rehearsal rooms.
- The wide hallway can be used by students that wish to study in a musical environment, as well as by musicians waiting to start their rehearsal.



ACOUSTICAL ENCLOSURE PANEL

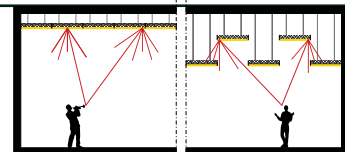


SECTION OF LOBBY EVENT AREA SHOWING THE ENCLOSURE FEATURE ■ Reflective surface ■ Diffusive surface

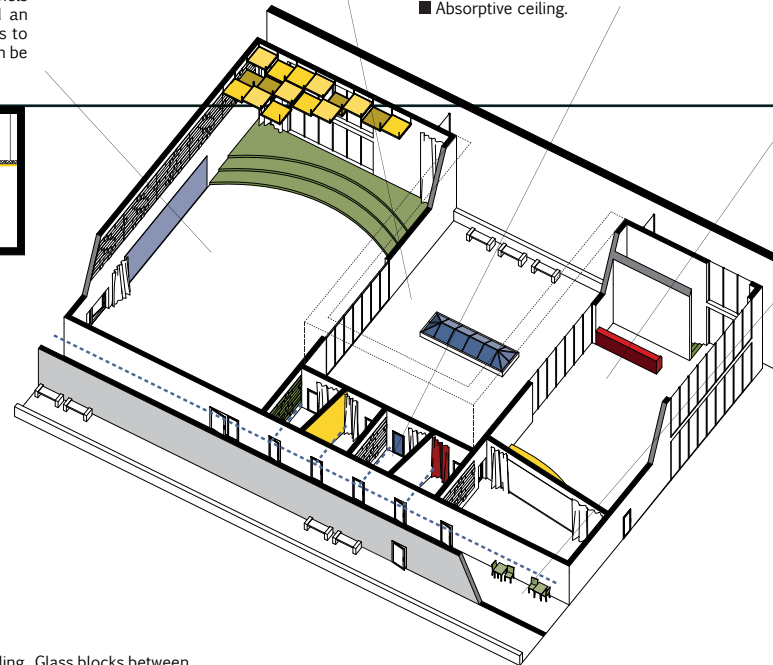
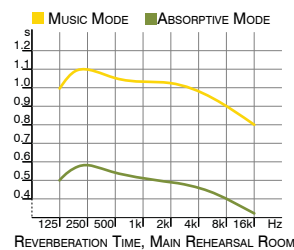
The spacious lobby is set on multiple floors with daylight flowing through a central shaft, supplementing the array of daylight provided through the sound insulating brick walls.

The wardrobes are situated on the ground floor, enabling the audience to make their entrance to the actual lobby liberated of their coats. A restaurant is situated on the third floor, provided with a balcony facing the Montreal skyline.

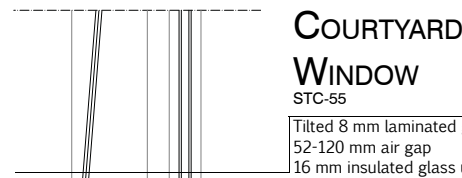
The first floor feature a large space useful for various events. A stage is provided for ensemble performances and speeches. To improve the acoustical properties of the space during performances, convertible panels can be tilted down to enclose the space and focus reflections toward the audience. In their default setting the panels act as ceiling diffusers.



SECTION OF MULTI-PURPOSE REHEARSAL ROOM



Rehearsal Room RC15 Courtyard 65 dBA



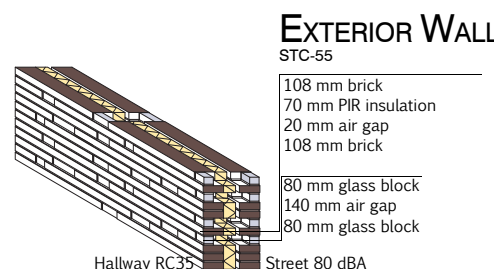
## COURTYARD WINDOW

- STC-55
- Tilted 8 mm laminated glass
- 52-120 mm air gap
- 16 mm insulated glass unit

## WALL TYPES

A double brick wall encloses the entire building. Glass blocks between the bricks let light inside while maintaining high sound insulation due to their thickness and small size.

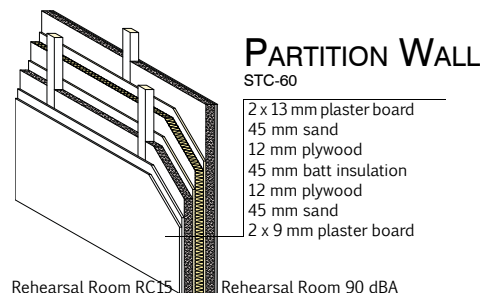
Two types of walls are used for soundproofing indoor noise. Both have similar sound transmittive properties, but one is load-bearing and set in concrete, and the other one is lighter and more easily constructed.



## EXTERIOR WALL

- STC-55
- 108 mm brick
- 70 mm PIR insulation
- 20 mm air gap
- 108 mm brick
- 80 mm glass block
- 140 mm air gap
- 80 mm glass block

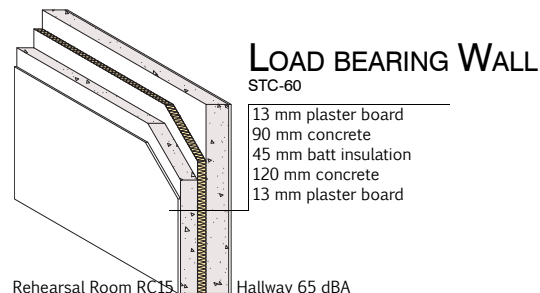
Hallway RC35 Street 80 dBA



## PARTITION WALL

- STC-60
- 2 x 13 mm plaster board
- 45 mm sand
- 12 mm plywood
- 45 mm batt insulation
- 12 mm plywood
- 45 mm sand
- 2 x 9 mm plaster board

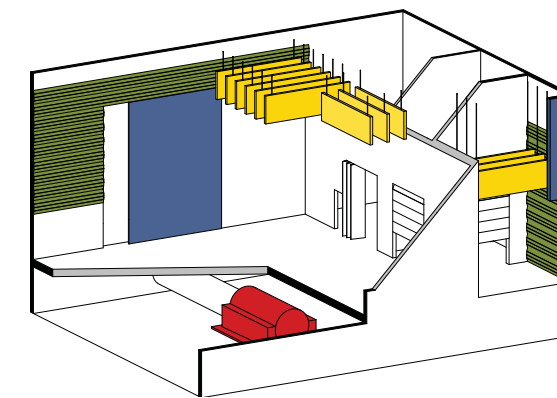
Rehearsal Room RC15 Rehearsal Room 90 dBA



## LOAD BEARING WALL

- STC-60
- 13 mm plaster board
- 90 mm concrete
- 45 mm batt insulation
- 120 mm concrete
- 13 mm plaster board

Rehearsal Room RC15 Hallway 65 dBA



## LOADING DOCK

- The loading dock is at the same height as the stage, making for good logistics.
- Sound baffles with porous absorbers in the ceiling for absorption of high frequencies.
- Slit absorbers on the walls for absorption of low and mid frequencies.
- A high space with a small opening toward the truck makes sure the noise is absorbed in the space and not transmitted to neighbouring areas.

## WORKSHOP AREA

### SCENE SHOP

- The scene shop is divided into four parts; central assembly hall, metal workshop, paint shop and carpentry. All workshops are attached to the assembly hall through large sound insulated doors for high flexibility and good working conditions.
- Porous sound baffles to reduce the noise level.
- Slit absorbers for absorption of low and mid frequencies.
- Sound proof double doors which allows a close proximity to the auditorium

## MECHANICAL EQUIPMENT ROOM

- The MER is located in the basement, beneath the scene shop, where it's isolated from noise sensitive spaces.
- Air ducts are fitted with silencers, preventing noise to spread in the ventilation system.
- Machinery mounted on spring isolators with rubber pads to reduce wave propagation through slabs.



### HALL SHAPE

■ The shape of the auditorium derives from the need of a multi-purpose hall. The fan shape combines the good visual properties of the conventional horse shoe shaped opera with the acoustic qualities of a rectangular concert hall.

□ The walls are made of the same type of bricks as the exterior, although shifted back and forth, making for high diffusion.



### DOUBLE SHELL

The auditorium is enclosed by two concrete shells of STC-65, separated from roof to foundation by a wide airspace.

■ The two walls create an immersive space which constitutes the transition into the auditorium. The space also acts as a sound sluice and since the walls are covered with heavy textile, good sound absorption is achieved.

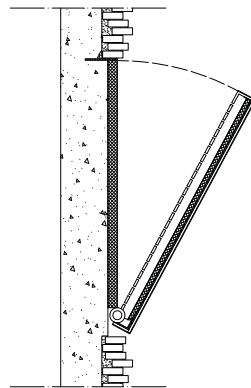
■ The sluice doors are supplied with a spring loaded seal to prevent sound leakage. When the door is closed, a lever is compressed, forcing a rubber seal onto the door jam, thus sealing the door tightly.

### REFLECTORS

■ The balcony fronts are plastered and tilted down, reflecting sound toward the stalls.

■ The overhead reflectors can be individually lowered to control reflections.

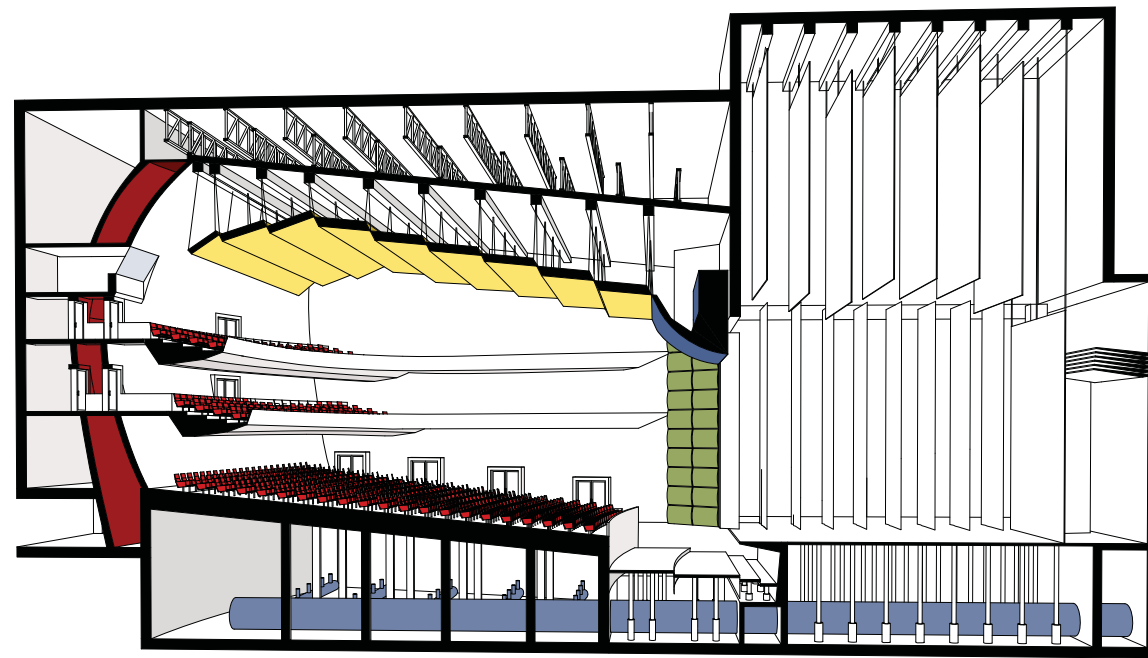
□ The ceiling above the reflectors is modeled as a perforated absorptive surface with a fiber wool layer behind. This absorbs the late sound reflections ensuring a high clarity.



TILTABLE WALL REFLECTOR 1:200

■ The balcony fronts are extended along the side walls, functioning as tiltable wall reflector. The panels have reflective plaster on the fronts and both porous and resonant absorbers on their backsides.

□ When tilted down they increase early reflections for the audience, and expose the absorptive back of the reflectors, increasing clarity and reducing reverberation time.



SECTION THROUGH STAGE AND AUDITORIUM 1:200

### FLYING BALCONIES

■ The two tiers of balconies are suspended from the back wall to ensure good sound envelopment.

□ The absence of side balconies and a steep angle ensures good vision for all seats.

### SEATS

■ The seats are arranged in the continental way, with wide rows for easy passage.

The slope of the stalls is steep to ensure a good view from every seat.

The seats are lightly upholstered to avoid sound overabsorption and provide similar acoustics regardless of the number of audience.

### PROSCENIUM

■ The top of the proscenium can be raised, resulting in a height variable between 9 and 11 meters (30'-36').

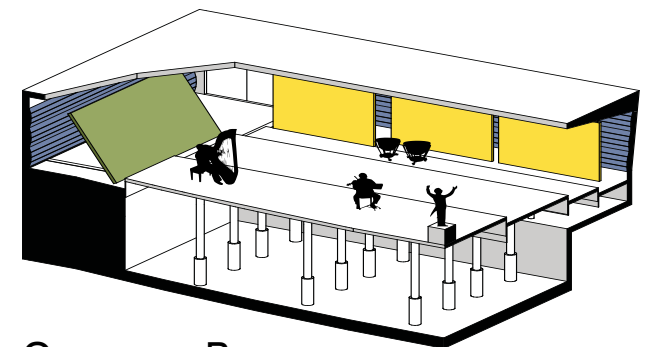
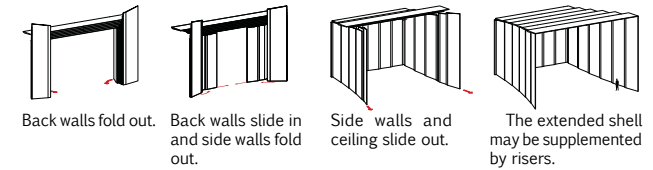
■ The side and top proscenium reflectors are scattering, convex reflectors which ensure an even distribution of sound from the orchestra throughout the hall.

### HVAC

■ Air is brought inside the auditorium through a duct coming from the mechanical equipment room, passing through a silencer, and into a plenum chamber below the stalls. The air finally enters the auditorium through outlets under each seat at a velocity of 1 m/s.

### STAGE SHELL

The stage shell is made of painted wood on steel plates and is easily folded and stored in the back of the stage. The shell is fully automated and can be unfolded quickly and effortlessly. The components are individually tilted along outbound curvatures, scattering the sound and distributes it in both the auditorium and inside the shell.



### ORCHESTRA PIT

■ Four platforms on separate lift systems. Two platforms can be raised up to stage level for orchestral performances.

■ Movable panels with reflective and absorptive surfaces on opposite sides for controlling sound level and balancing different sections of the orchestra.

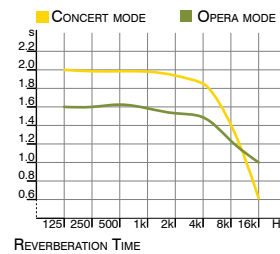
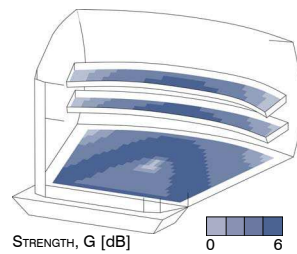
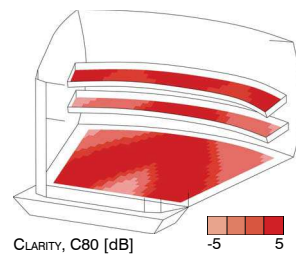
■ Reflective side panels, which can slide in to reduce the size of the pit. The angle is adjustable to create different modes of sound propagation from the pit.

■ Diffusive slit absorbers on the walls to ensure an optimal low frequency response from the orchestra and control the work environment inside the pit.

□ Back wall tilted to avoid flutter echoes. Diffusive stage overhang.

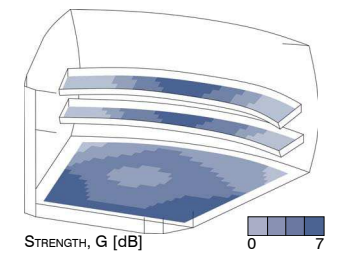
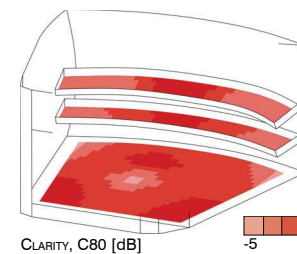
### OPERA HALL MODE

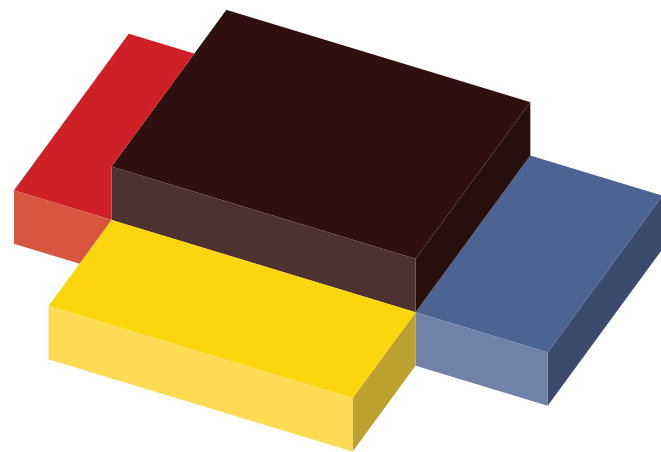
The main use of the auditorium is opera. In opera mode, the clarity is high and the reverberation time is around 1.5 seconds. This is achieved by putting the ceiling reflectors in a low setting and tilting the wall reflectors down. This results in more early reflections towards the audience and increased absorption.



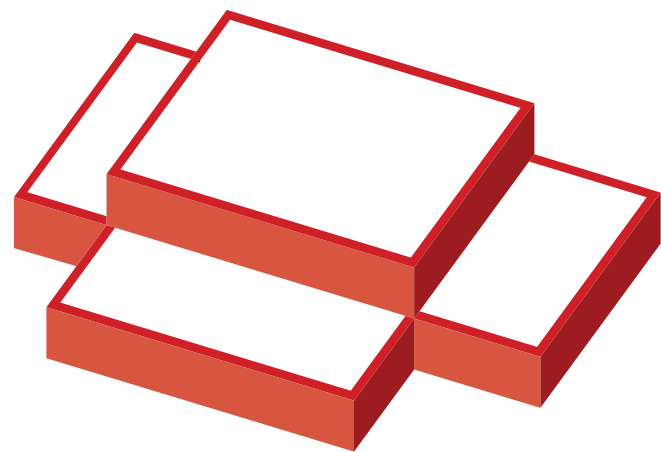
### CONCERT HALL MODE

In concert mode, the reverberation time is expected to be around 2s. To achieve this, the ceiling reflectors are lifted up and the wall reflectors tilted into upright position. To accommodate a large orchestra, the orchestra pit is raised to the stage level, and the stage shell provides direct sound from the orchestra towards the audience. The proscenium reflector is raised to allow sound from the back of the stage to spread in the auditorium.

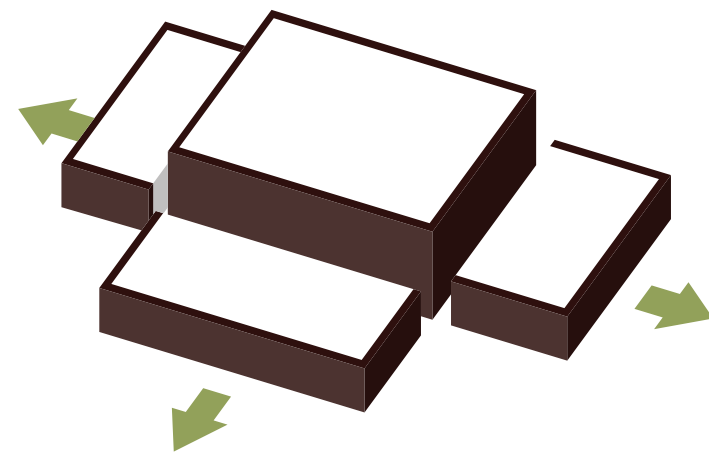




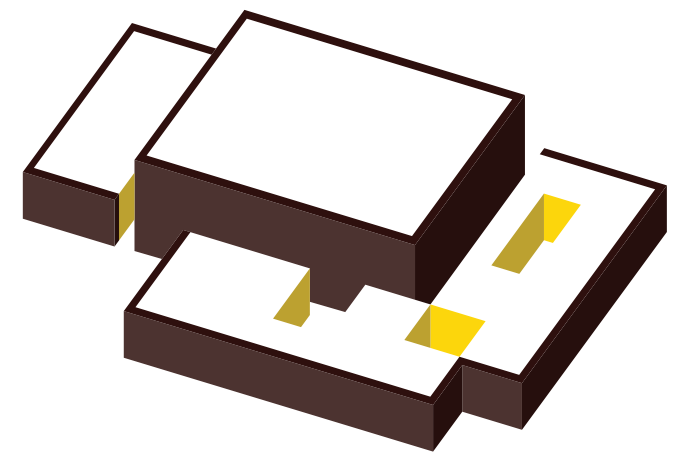
Uppdelning av byggnaden  
 ■ Publikt  
 ■ Semipublikt  
 ■ Professionellt



■ Slutet, ljudisolerande yttre

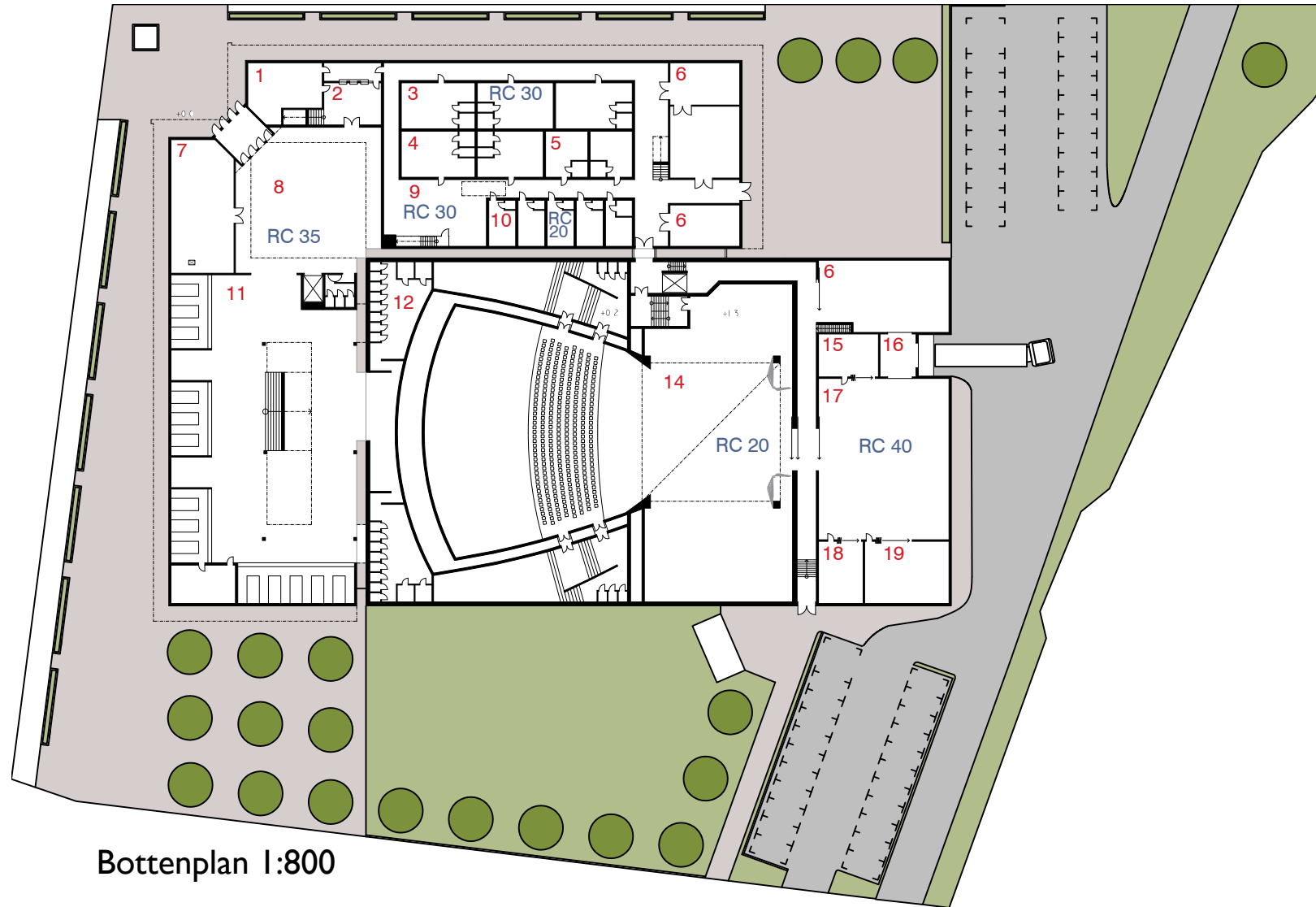


■ Separation av byggnadskroppar förhindrar ljudtransmission i strukturen.

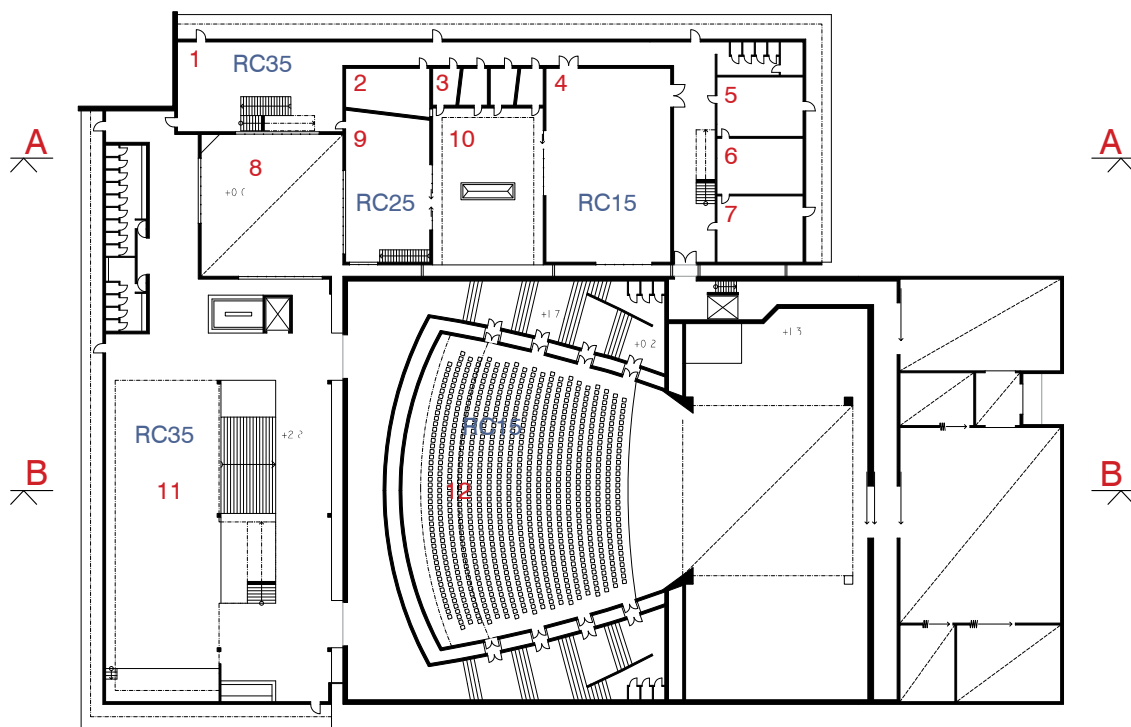


■ Ljus släpps in i byggnadens inre uppifrån.

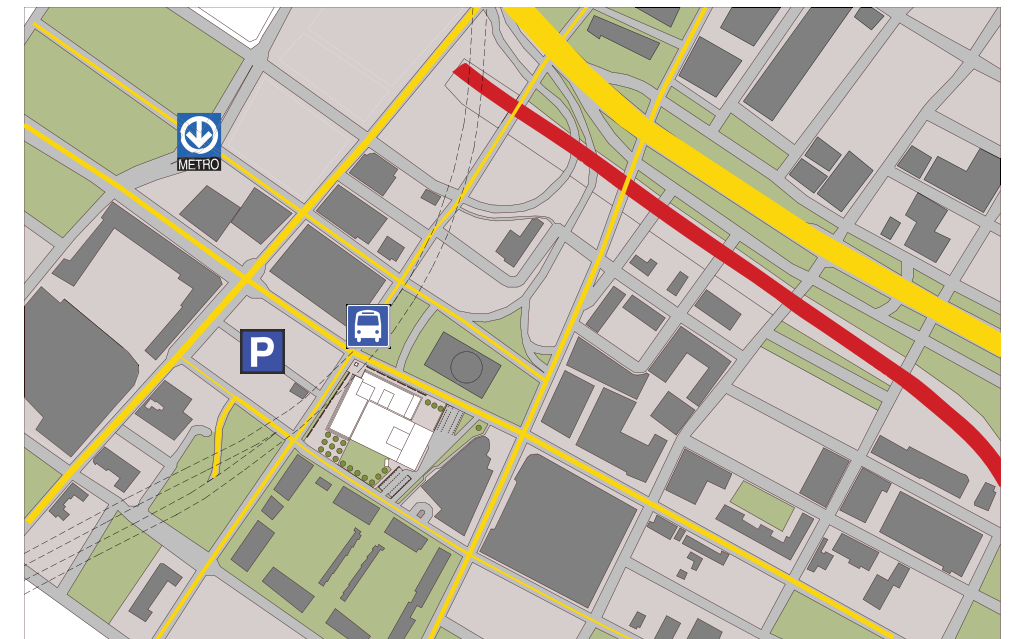
# BYGGNADEN



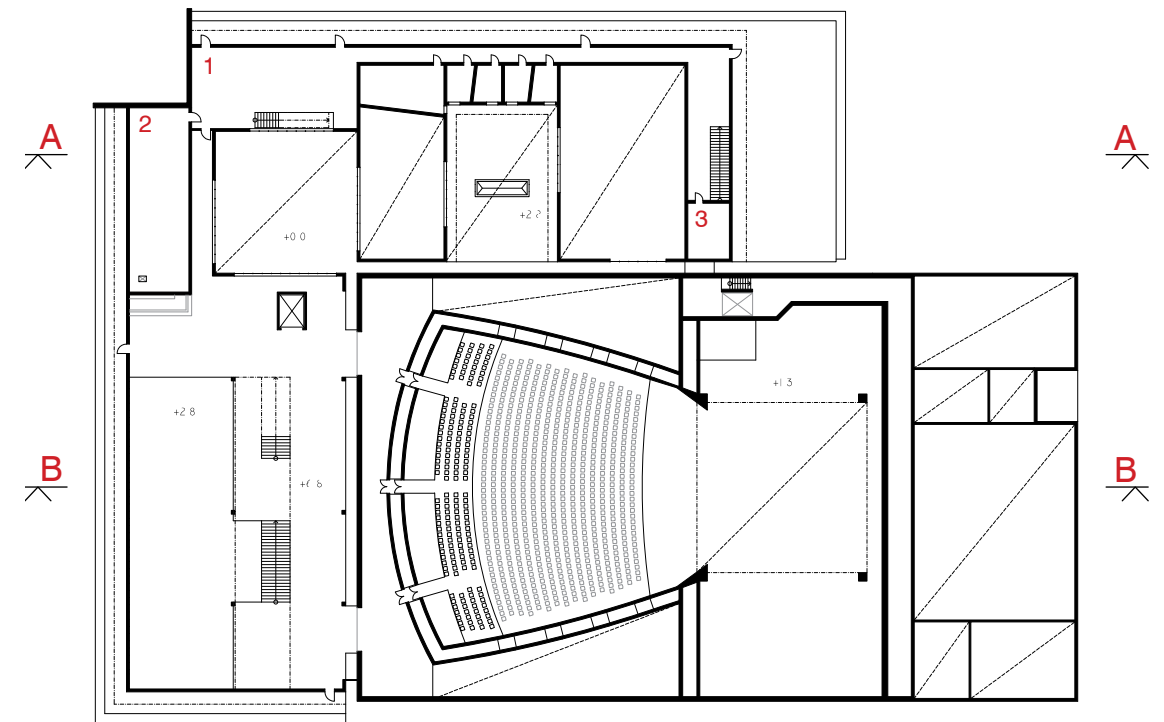
Bottenplan 1:800



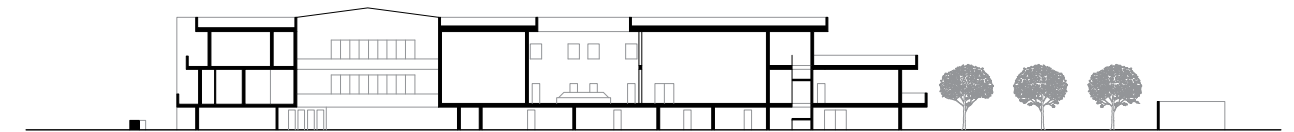
Plan I 1:800



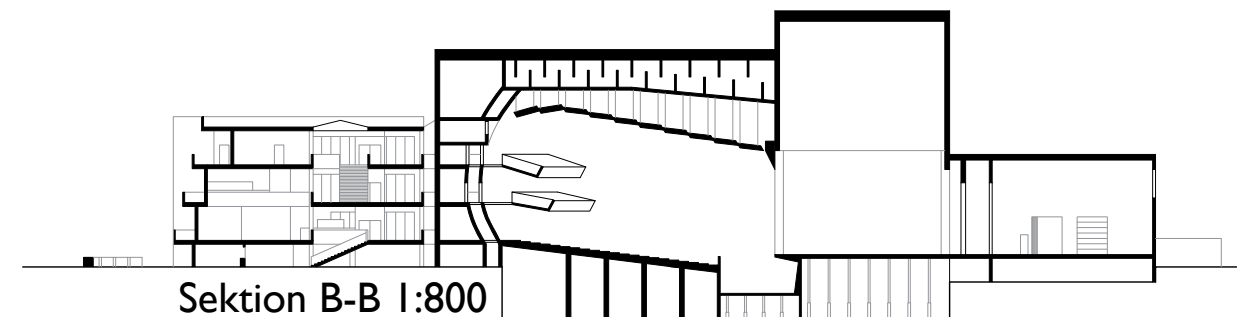
Situationsplan 1:8000



Plan 2 1:800



Sektion A-A 1:800



Sektion B-B 1:800

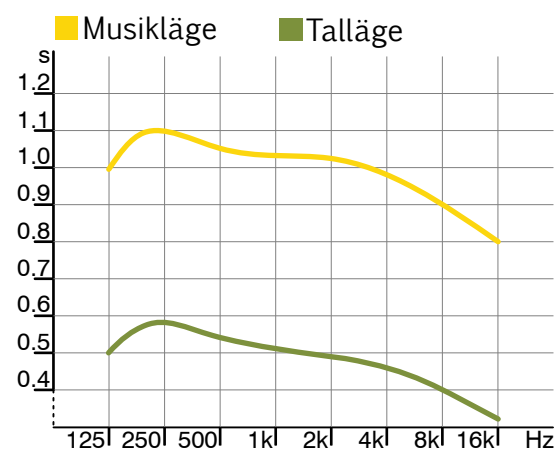
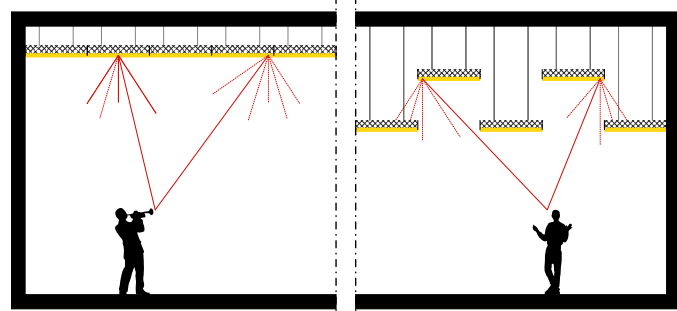
# SEMIPUBLIKT

## Stort Övningsrum

■ Infällbara nivåskillnader för körövningar kan också användas som scen.

■ Spegel för dansövningar. Kan täckas med gardin för ökad ljudabsorption.

■ Rummets akustik kan regleras med individuellt höj- och sänkbara takplattor. Plattorna är diffuserande på undersidan och absorberande på ovansidan. Genom att sätta plattorna på olika höjd kan efterklangstiden varieras för att passa allt från orkesterrepetitioner till workshops och föreläsningar.



Variabel Efterklangstid

## Innergård

■ Ger ljus till övningsrum och green room från en plats skyddad från trafikbuller.

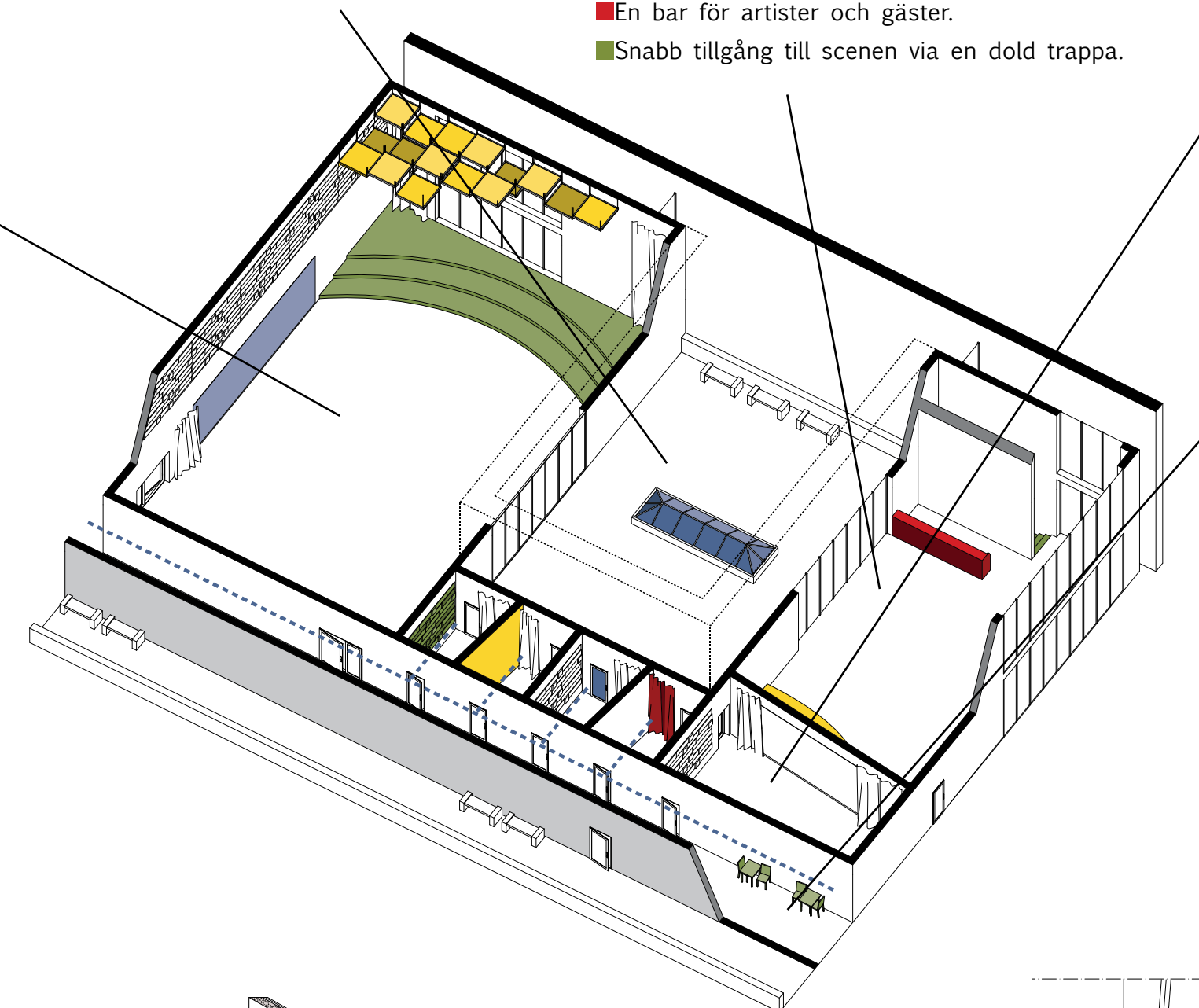
■ En ljusbrunn leder ned ljus till bottenvåningen.

## Green Room

■ Scen för talare och mindre föreställningar i hörn med reflekterande väggar som hjälper till att sprida ljudet ut i lokalen.

■ En bar för artister och gäster.

■ Snabb tillgång till scenen via en dold trappa.



## Soloövningsrum

■ Diffusorer med slumpvisa oregelbundenheter.

■ Vinklade väggar för att undvika fladdereko.

■ Ljudisolerade glasdörrar med mikroperforerade ljudabsorbenter.

■ Gardiner ger varierbar absorption och insynsskydd.

## Korridor

■ Agerar ljudbuffert mellan gatan och övningsrummen.

■ En dubbel tegelvägg ger god ljudisolering. Glasade perforeringar släpper in ljus och skapar ett intressant skuggspel.

■ Ventilationstrummor med ljuddämpare är monterade i korridorrens tak för att undvika flanktransmission mellan övningsrummen.

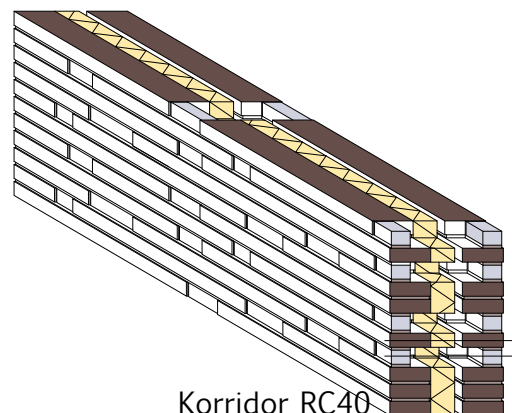
■ Den breda korridoren kan användas av studenter som vill studera i en musikalisk miljö och av musiker som väntar på sin repetition.

## Yttervägg

STC-55

108 mm tegel  
70 mm PIR-isolering  
20 mm luftspringa  
108 mm tegel

80 mm glasblock  
140 mm luftspringa  
80 mm glasblock

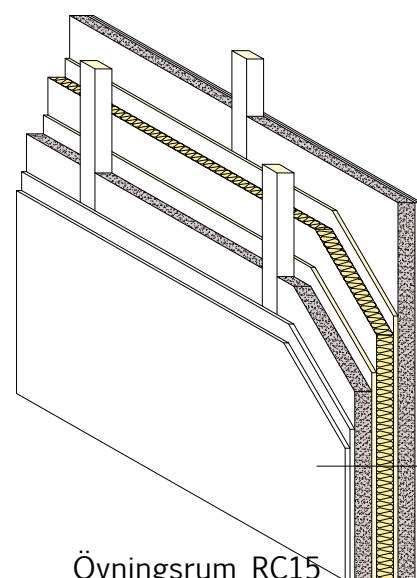


Korridor RC40 Gata 80 dBA

## Mellanvägg

STC-60

2 x 13 mm gips  
45 mm sand  
12 mm plywood  
45 mm mineralull  
12 mm plywood  
45 mm sand  
2 x 9 mm gips

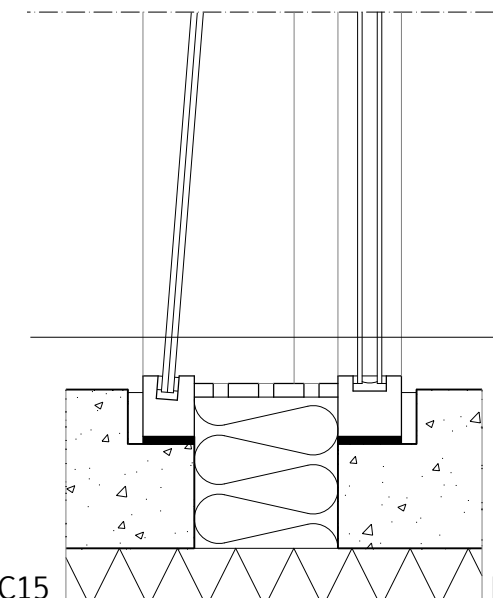


Övningsrum RC15 Övningsrum 90 dBA

## Fönster

STC-55

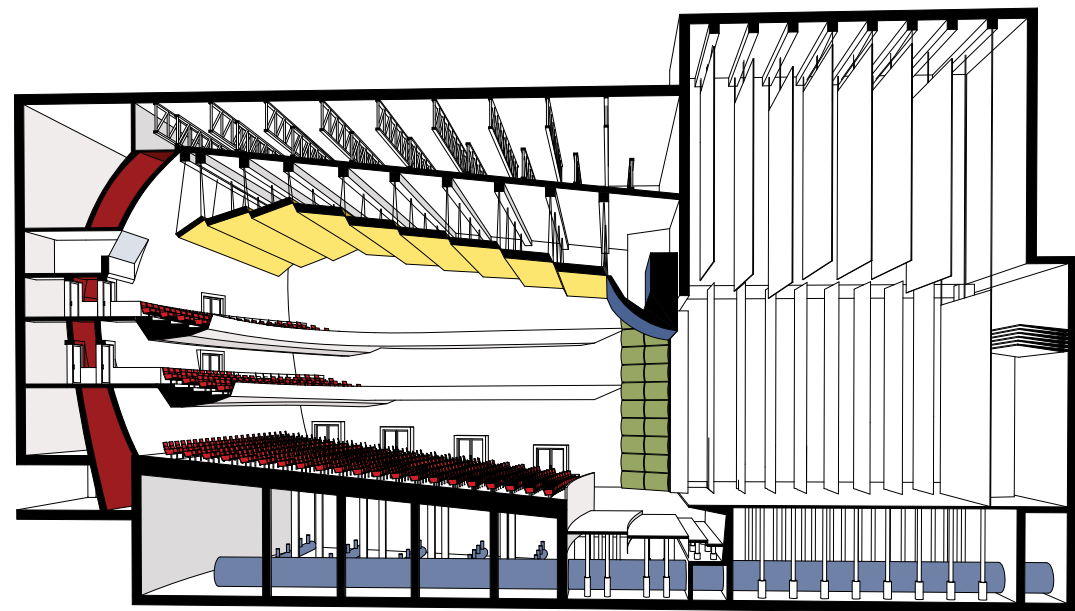
Lutat 8 mm laminerat glas  
52-120 mm luftspringa  
16 mm isolerruta



Övningsrum RC15 Innergård 65 dB

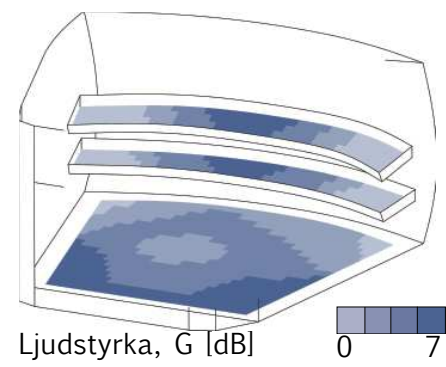
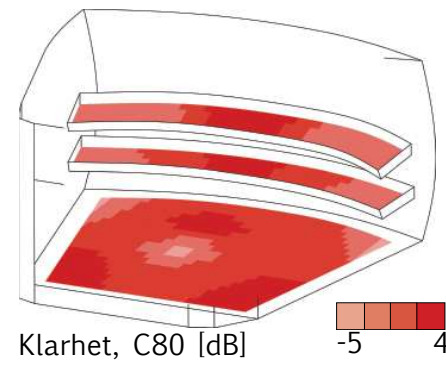


# AUDITORIUM

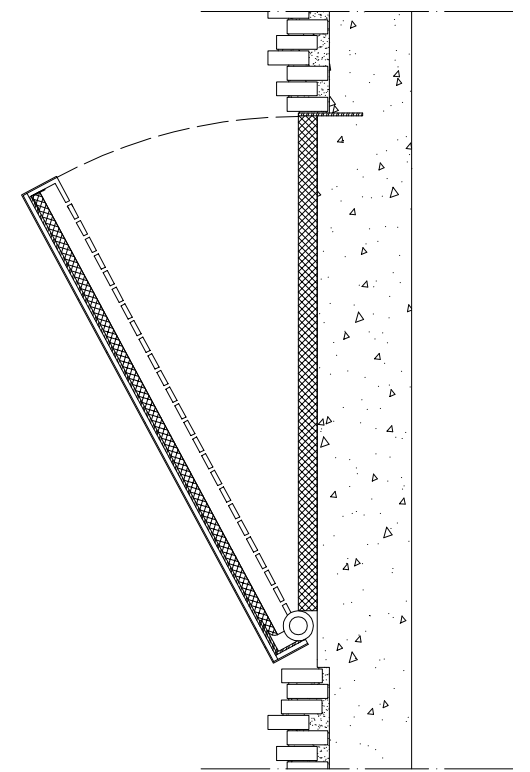
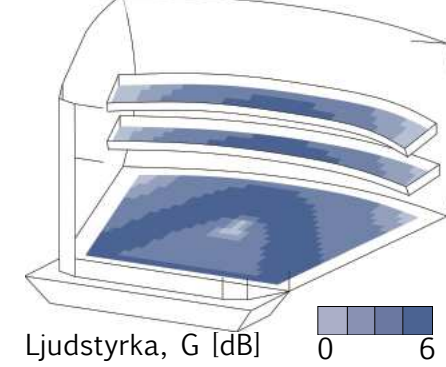
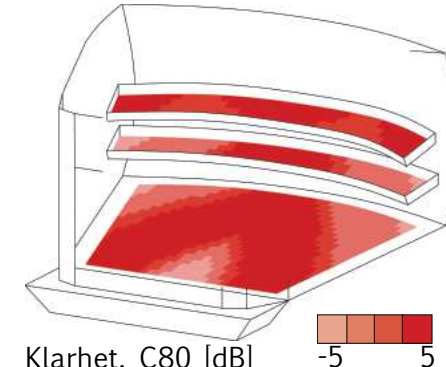


Sektion genom operasal 1:400

Koncertläge



Operaläge



Varierbar Vägreflektor 1:20

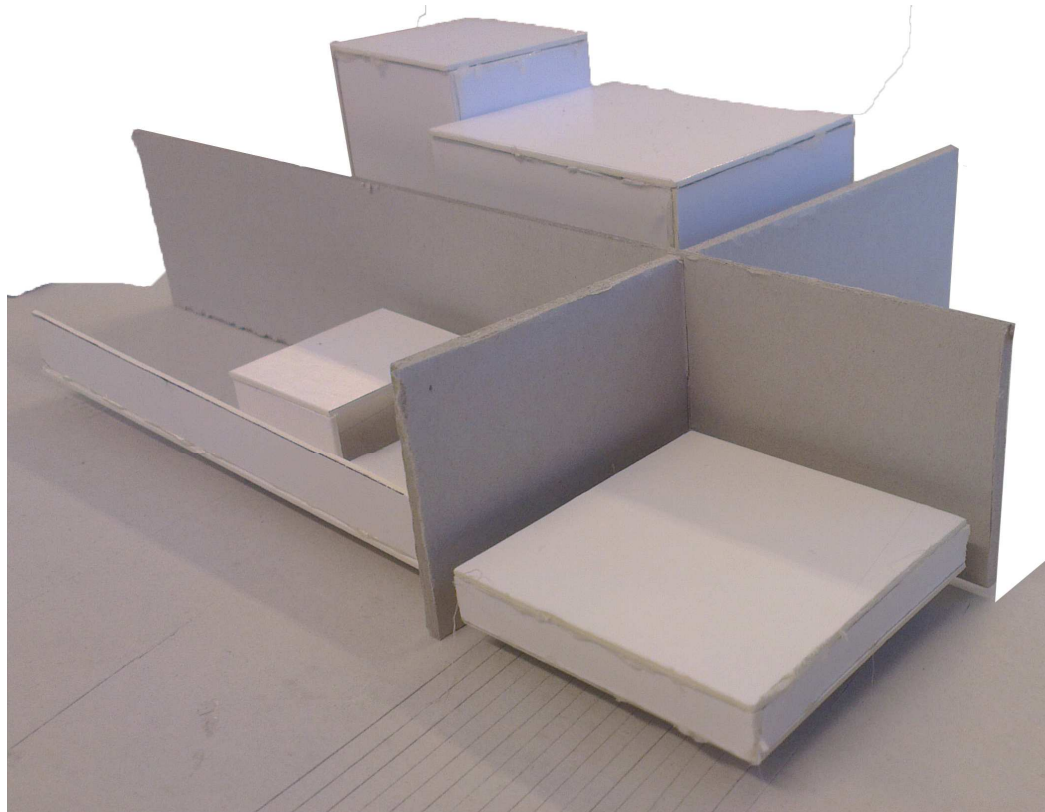


# PROCESS

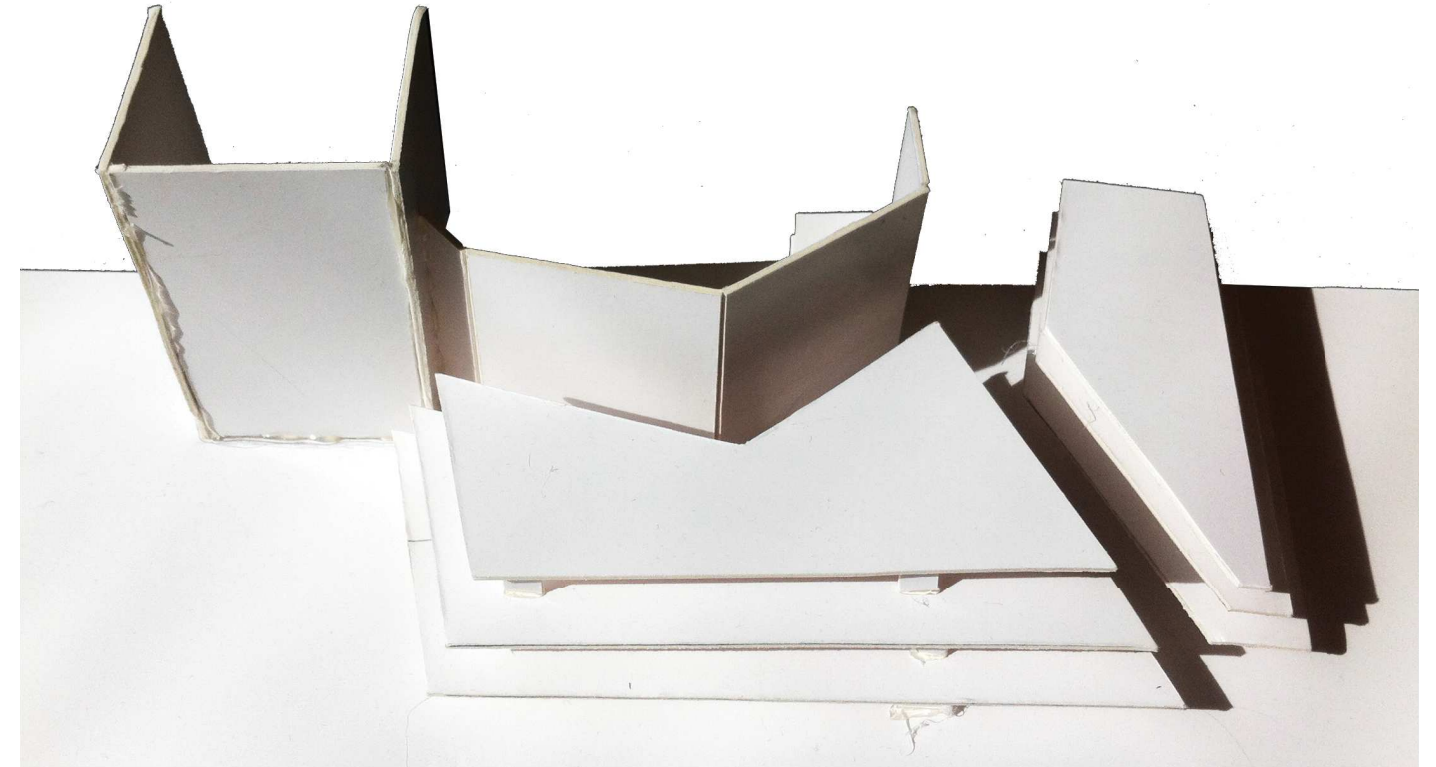
Skissprocessen skedde till stor del i modell. Fokus låg på byggnadens övergripande koncept och form. Detta omprövades flera gånger efter att vi gått en bit vidare med flera olika idéer, men av olika anledningar stött på problem.

Vissa element fanns dock kvar från de allra första skisserna, till exempel ett stort ljusinsläpp ovanifrån och balkongerna, som dock antog olika former och funktioner i byggnaden under processens gång.

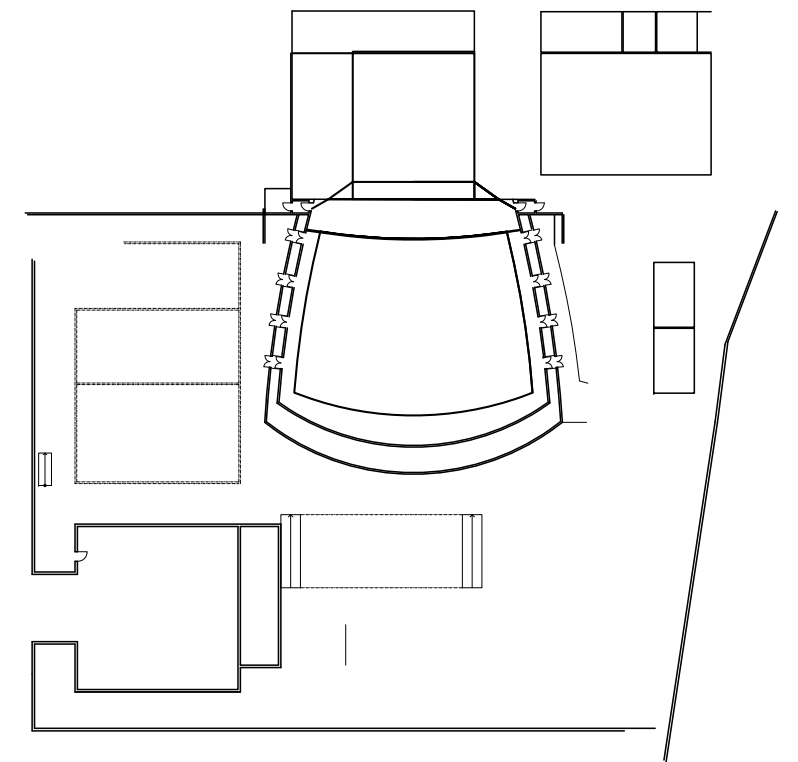
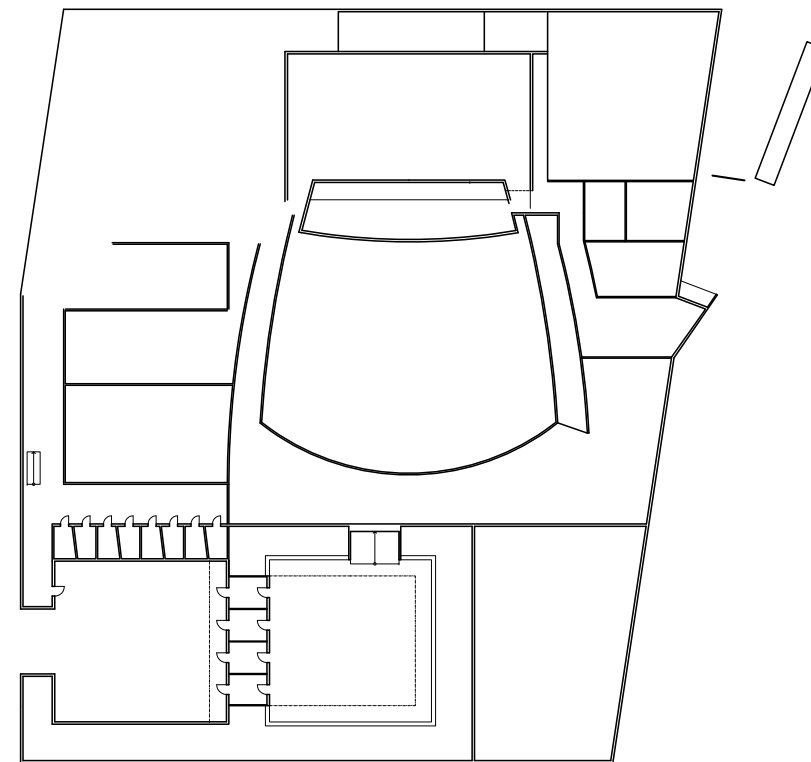
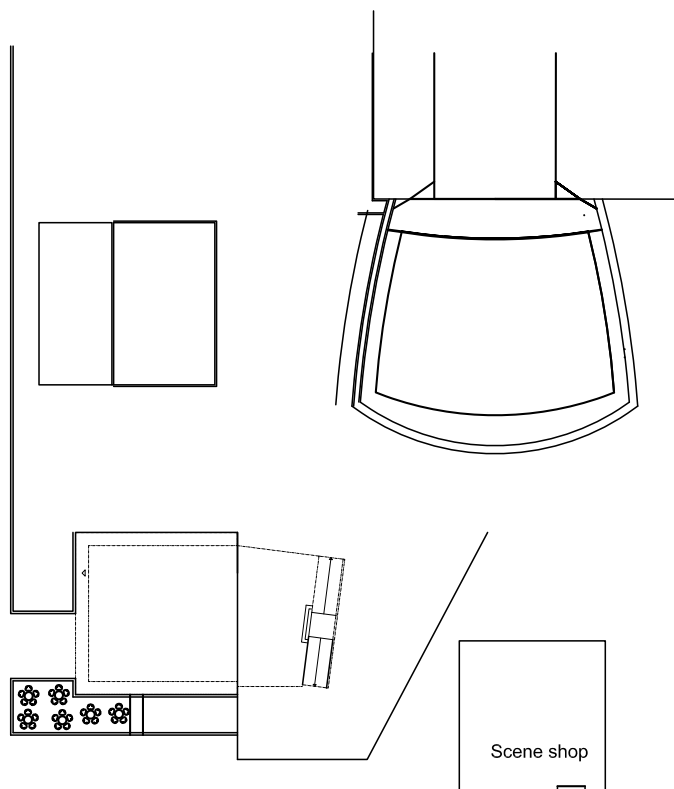
Att få ihop entrélösning med lobby och atrium var något som krävde en del omtanke och omtagningar, medan den semipublika delen löste sig naturligt.



Förkastat koncept med avskiljande skivor istället för de schakt som i slutändan kom med i projektet.



Tidig skissmodell som visar de terrasserade balkongerna och schakten mellan byggnadskropparna som till viss del blev kvar och till viss del blev byggnadens centrala atrium.



Planlösningsskisser I-1000. Fokus låg här på att hitta en bra lösning för förhållandet mellan entré och lobby, som kan ses i nedra vänstra hörnet.

# REFLEKTION

Projektets styrka består i dess genomtänkta lösningar både i stor och liten skala. Få saker har lämnats åt slumpen. Den semipublika delen har legat i fokus vid projekteringen, och har därför många kvaliteter, till exempel innergården som omgärdas av övningsrum och greenroom.

Även atriet som utgör byggnadens entréhall och balkongerna längs fasaderna utgör fina kvaliteter, något som dock inte framkommit tydligt i presentationen.

Auditoriet fungerar bra, men skulle kunnat må bra av ytterligare iterationer för att uppnå den höga nivå som eftersträvades, både vad det gäller akustik och form. Till exempel takreflektorerna skulle kunnat finjusteras ur akustisk synpunkt och implementeras mer i det övergripande konceptet ur estetisk.

Det projektet saknar är ett tydligare, mer lättgreppbart

koncept med ett namn kopplat till sig. Projektet bygger mer på sin helhet i detaljerna än i det övergripande.

Motiverad kritik kom också mot detaljer som lämnats åt slumpen, till exempel ljusinsläppet på innergården, som blivit mycket bättre med ett uns mer omtanke.

Presentationens färgkodning gick inte hem hos kritikerna, vilken jag dock fortfarande står bakom.